ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
ECONOMIC STUDIES

Volume 34(8), 2025

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TERRORISM, POLICY STRINGENCY, AND GREEN GROWTH: A STUDY OF BRICS[3]

This study emphasises the growing importance of green growth in light of the environmental challenges posed by industrialisation and globalisation. Green growth is imperative for addressing environmental challenges by mitigating climate change and promoting resource efficiency. It drives economic development through innovation, job creation, and resilience to environmental risks, contributing to a more stable and competitive global economy. Additionally, green growth enhances societal well-being by improving public health, raising living standards, and fostering equitable development. The Environmental Policy Stringency Index (EPS), a critical indicator for assessing the severity of national environmental regulations, serves as the focus point. Along with policy stringency, terrorism appears to have a suppressing effect on green technological innovation. Additionally, there are implications for environmental sustainability, as terrorism is associated with financial losses and increased CO2 emissions. The study focuses on the role of policy stringency and terrorism in the green growth of BRICS countries, acknowledging their critical role in world development. Other variables considered include political stability, control of corruption, population, renewable energy consumption, and foreign direct investment from 1996 to 2020. For empirical purposes, this study employed a panel threshold regression model. The nuanced relationship between terrorism, institutions, and green growth has been found, where institution quality shows threshold effects. The impact of environmental policy stringency on green growth is also discussed, with market-based policies consistently demonstrating a positive influence. Based on the findings, a few policy suggestions were also discussed.

Keywords: Green Growth; EPS; Panel Model; Terrorism
JEL: O4; C5; Q5

1. Introduction

According to the Organisation of Economic Cooperation and Development (OECD), green growth fosters economic development while preserving natural assets and environmental quality (Dercon, 2014). This concept has gained significant international recognition in recent years, representing an integration of economic growth with substantial environmental

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[3] This paper should be cited as: *Jajoo, A., Neog, Y. (2025). Terrorism, Policy Stringency, and Green Growth: A Study of BRICS. – Economic Studies (Ikonomicheski Izsledvania), 34(8), pp. 132-146.*

protection (Jacobs, 2012). The necessity of green growth arises from the increasing risks associated with industrialisation and globalisation, which can lead to environmental degradation, climate change, and biodiversity loss (OECD, 2015). The argument for green growth posits that economic development can coexist with reduced environmental impacts, a notion rooted in theoretical frameworks dating back to the 1970s (Huberty et al., 2011). Following the 2008 economic downturn, a more robust version of green growth emerged, suggesting that environmental protection can actively promote economic development. Policies aimed at environmental sustainability are seen not as impediments to economic progress but as catalysts for enhanced output and improved living standards, with positive effects achievable in the short term (Jacobs, 2012). Environmental protection measures encompass a range of regulations, varying across countries and industries, including voluntary programs and market-based instruments (Albrizio et al., 2017). The impact of stringent environmental policies is a matter of debate, with some arguing they hinder economic activity and competitiveness, while others, such as proponents of the Porter Hypothesis, contend they drive innovation and productivity growth (GGKP, 2015; Porter & van der Linde, 1995). The Environmental Policy Stringency Index (EPS) is an indicator designed to measure the rigour and severity of environmental policies implemented at the national level (OECD, 2024). A higher EPS index reflects more stringent environmental regulations and policies within a country (Botta et al., 2014). The EPS index is deemed superior in capturing multidimensional policies and reducing them into a comparable country-specific measure (Albrizio et al., 2017; Martínez-Zarzoso et al., 2019).

By incorporating the EPS into our analytical framework, we aim to explore its influence on green growth, acknowledging its potential to shape economic practices aligned with sustainability objectives. Three primary considerations guide the structure and aggregation of the index. Firstly, equal weighting is assigned to each sub-index, which includes market-based, non-market-based, and technology support components. Different countries employ varying combinations of policy instruments to regulate emissions, with some emphasising pricing instruments like carbon taxes. In contrast, others adopt non-market-based policies such as emission limits or standards. Secondly, each sub-index is designed to be self-contained, functioning as a standalone indicator, ensuring that policy weights within each sub-index add up to one. Thirdly, equal weighting is applied to the policies within each sub-index. Kruse et al. (2022) describe the index and basic statistics and compare them with other environmental policy measures or proxies. Terrorism has significant implications for green growth due to its clear influence on green technology innovation and environmental sustainability. According to Zheng et al. (2021), severe terrorist attacks markedly reduce green innovation, particularly in renewable energy technology. This decline is observed globally and is pronounced in OECD countries and high-income nations. The findings underscore how terrorism can impede the advancement of green technology, potentially hindering the growth of environmentally friendly activities and enterprises. Understanding the impact of terrorism on green innovation and environmental sustainability enables policymakers and stakeholders to develop mitigation strategies to foster a more resilient and sustainable future.

This study examines the critical relationship between green growth, policy stringency, and terrorism. Additionally, it considers political stability and control of corruption as indicators of institutional quality. Other macroeconomic variables, such as population, renewable energy, and foreign direct investment (FDI) inflows, are included to control for their effects on green growth. The subsequent sections will cover the literature review, methods and data, results and discussion, and conclusions.

1.1. BRICS and the Significance of the Study

Green growth is a crucial strategy for nations striving to achieve environmentally sustainable development (Zhou et al., 2022). The BRICS countries – Brazil, Russia, India, China, and South Africa – are of particular significance to this study due to several interconnected factors that position them at the forefront of the global discourse on sustainable development and green growth. Together, the BRICS nations cover 29.3% of the world's land area and are home to 41% of the global population. Collectively, they contribute significantly to the global economy, accounting for 24% of global GDP and 16% of all world trade (Ministry of External Affairs, India, 2021). As members of the Group of Twenty (G20) forum, the economic growth, political influence, resource utilisation, and trade volumes of BRICS nations influence them in shaping global economic trends.

The BRICS countries display diverse political, economic, and social structures, leading to various policy approaches with potential global repercussions. Given the interconnectedness of environmental resources, the actions of these nations significantly impact global environmental outcomes. Previous research on the effects of Foreign Direct Investment (FDI) or Environmental Policy Stringency (EPS) on green growth has predominantly focused on OECD countries or China. These studies often overlook the roles of population dynamics and political factors in explaining the effects of policy stringency on green growth. This project aims to build on existing research by exploring the nuanced dynamics of green growth, focusing on the role of Environmental Policy Stringency (EPS) within the BRICS economies. Doing so seeks to provide a more comprehensive understanding of the factors influencing green growth in these influential nations.

2. Literature Review

The relationship between green growth and macroeconomic factors has been extensively debated. However, examining policy stringency and its impact on green growth remains less explored. Chen and Tanchangya (2012) delve into the intricate relationship between environmental, technological innovations, and environmental policy stringency and their consequential impact on green economic growth in China. Utilising an Autoregressive Distributed Lag (ARDL) model, their study highlights the pivotal role of these factors in pursuing sustainable development by examining both short-term and long-term effects. The results underscore the affirmative impact of environmental technology on green growth while delineating the nuanced effects of environmental policy stringency in both the short and long run. Wu and Zhang (2024) discuss the influence of environmental technology and stringent policies on green growth, emphasising the necessity of aligning environmental policies with technological advancements for sustainable economic development in China. Tawiah et al. (2021) highlight the complex interplay of economic, environmental, and policy factors influencing green growth. Economic growth is vital for sustainable development, affecting carbon emissions and environmental performance (Alam & Kabir, 2013). While economic growth can lead to reduced carbon emissions when accompanied by pollution-reducing policies, trade-offs between growth and environmental quality exist (Rahman et al., 2020). Investments in clean energy and advanced technologies can effectively moderate pollution and improve economic growth (Muhammad & Khan, 2019). Furthermore, economic growth can positively interact with environmental performance (Chang & Hao, 2017), though environmental costs associated with increased consumption and production must be considered (Wang et al., 2019). Policymakers must balance economic growth with sustainable environmental policies to mitigate adverse environmental effects (Shahbaz et al., 2013).

Foreign direct investment (FDI) and trade openness influence environmental quality significantly. According to Ayamba et al. (2020), these economic activities can have substantial environmental impacts. The pollution haven hypothesis posits that FDI and trade may encourage the relocation of pollution-intensive industries to countries with less stringent environmental regulations (Haug & Ucal, 2019). Conversely, the pollution halo hypothesis suggests that internationalisation can lead to the transfer of advanced technologies and improved environmental practices (Birdsall & Wheeler, 1993). Balancing the benefits of internationalisation with environmental sustainability necessitates the implementation of effective policies and regulations (Shahbaz et al., 2019). Robust institutions and stringent environmental policies are essential to channel FDI into environmentally sustainable initiatives (Hille & Shahbaz, 2019). Energy consumption plays a critical role in environmental degradation, as highlighted by Bilgen (2014). On the other hand, renewable energy consumption has been identified as a beneficial factor for green growth (Saidi & Omri, 2020). The extent to which renewable energy contributes to reducing carbon emissions can vary based on several factors, including the specific type and source of renewable energy (Jebli & Youssef, 2017). A comprehensive renewable energy system is crucial to reduce emissions and effectively promote sustainable growth (Pata, 2018).

Institutional quality, including effective governance, significantly influences the trajectory of green growth (Sarkodie & Adams, 2018). Effective enforcement of environmental regulations and governance positively impacts environmental sustainability (Abid, 2017). However, an excess of rapidly changing regulations can inhibit economic growth and stifle innovation in environmental sustainability (Nguyen et al., 2018). Thus, balancing and adopting an optimal combination of institutional quality components is crucial for sustainable development and green growth (Abid, 2017). Zheng et al. (2021) explore the complex relationship between terrorism and green technological innovation in renewable energy across 87 economies from 1991 to 2017. The study reveals that severe terrorist attacks lead to a notable decrease in green innovation, particularly in renewable energy technologies, within economies that are part of the Organisation for Economic Cooperation and Development (OECD) (Gaibulloev & Sandler, 2008). This decline is most pronounced in OECD countries and high-income nations, highlighting the varied impacts on different economic landscapes. The analysis also indicates that wind energy innovation suffers the most significant decline in response to terrorist threats, underscoring the sector-specific effects of terrorism on green technological advancements.

Furthermore, the research identifies a differential impact of terrorism based on the level of existing green innovation in economies. Countries with lower levels of green innovation experience a more pronounced repression of green technological advancement following terrorist attacks, whereas economies with robust green innovation capabilities show a relatively minor impact (Chen et al., 2021a). This nuanced understanding emphasises the importance of considering a nation's existing innovation landscape when assessing the effects of terrorism on green technological progress. Zheng et al. (2021) examine the moderating role of various economic factors in shaping the impact of terrorism on green innovation. They find that countries with more significant high-tech exports and vital manufacturing sectors experience a more significant decline in renewable energy innovation when faced with terrorism threats (Balsalobre-Lorente et al., 2018). This finding highlights the interconnectedness of terrorism, technological innovation, and economic fundamentals, emphasising the need for a comprehensive approach to addressing these multifaceted challenges.

Tahir et al. (2022) utilise a predictive model to assess the impact of terrorism, an underexplored factor, on environmental sustainability in the MENA region from 2002 to 2019. They test the validity of the Environmental Kuznets Curve (EKC) hypothesis and highlight terrorism's detrimental effects on the environment, national economies, and populations. Terrorism is associated with financial losses and significant CO2 emissions, contributing to environmental degradation and poor air quality (Crawford, 2019; Bildirici & Gokmenoglu, 2020). According to the Global Terrorism Index (2019), terrorism in the MENA region from 2002 to 2018 resulted in over 93,700 deaths and economic losses, amounting to approximately US$11.9 billion. Their results indicate that terrorism increases CO2 emissions, while trade openness and urbanisation favour environmental sustainability, as evidenced by a negative correlation with CO2 emissions (Khan et al., 2021). Causality tests reveal a unidirectional causality from CO2 emissions and urbanisation towards terrorism, energy consumption towards urbanisation, and per capita income towards CO2 emissions. With a growing consensus on the risks of environmental degradation, sustainable development (SD) is receiving increased attention (Jan et al., 2021). M Tahir et al. (2022) underscore the importance of SD, defined by the World Commission on Environment and Development (WCED, 1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This concept is pivotal in addressing global risks, including climate change, and emphasises the urgency of reducing carbon emissions, which contribute to environmental degradation and adversely affect society and the economy (Tseng et al., 2020). The study highlights the role of the United Nations' Sustainable Development Goals (SDGs) in driving efforts by governments and non-state actors to enhance social well-being, economic development, and environmental sustainability (Jan et al., 2021).

Lu and Yan (2022) analysed provincial data from 2007 to 2019 to assess the state of inclusive green growth across China's regions, focusing on the relationship between foreign direct investment (FDI) and this growth. China's pursuit of inclusive green growth relies on FDI as a crucial avenue for global integration, capital accumulation, and technology transfer (Ren et al., 2021). Notably, FDI helps address challenges associated with rapid economic growth, such as environmental pollution and regional imbalances (Liang et al., 2021; Azman-Saini and Law, 2010). Recognising the importance of environmental considerations, the study aligns with China's "14th Five-Year Plan," which emphasises ecological civilisation and shared prosperity (Sun et al., 2020). The influx of FDI, which exceeded one trillion yuan in 2021, helps fill funding gaps for green development and brings technology spillovers and high-tech talent (Vujanović et al., 2021; Behera & Sethi, 2022). In the case of policy stringency, Arjomandi et al. (2022) examine the relationship between environmental policy stringency, environmental spending, and the growth of environmental GDP and productivity in OECD nations. Using the Pooled Mean Group Autoregressive Distributed Lag model, they find that government expenditure on environmental protection boosts national output in the short term. However, in the long run, stricter environmental policies and spending can slow down 'green' GDP and productivity growth, with policy stringency having a less pronounced impact. These findings challenge the Porter Hypothesis, suggesting that environmental policies may hinder economic activity and growth over time.

This research addresses significant gaps in the existing literature on green growth, terrorism, and environmental policy stringency. One key contribution is the nuanced exploration of the relationship between terrorism and green growth in BRICS nations. Another critical gap this research addresses is the relationship between environmental policy stringency and green growth. Furthermore, the research extends the literature by incorporating a threshold effect in the context of terrorism and environmental policy stringency. This methodological innovation enhances understanding of when and how these factors significantly influence sustainable development outcomes in BRICS economies. The introduction of threshold variables, such as political stability and control of corruption, offers a more detailed perspective on the dynamics between terrorism, environmental policies, and green growth, contributing to a more comprehensive theoretical framework for these nations.

3. Data and Methodology

This section will discuss the data sources, variables, and methodology adopted in the study.

3.1. Data and variables

The analysis includes independent variables, as detailed in Table (1), such as the Environmental Policy Stringency Index (EPS, sourced from OECD), Environmental Policy Stringency of Market-Based Policies (MEPS, sourced from OECD), Environmental Policy Stringency of Non-Market Based Policies (NMEPS, sourced from OECD), Terrorism (TERR, sourced from Global Terrorism Database), Political Stability (PS, sourced from WDI), Control of Corruption (COC, sourced from WDI), Population, Population Growth (POP, sourced from WDI), Renewable Energy Consumption as a percentage of Total Energy Consumption (REC, sourced from OECD), and inflow of Foreign Direct Investment as a percentage of GDP (FDI, sourced from OECD). The dependent variable is Green Growth (GG, sourced from WDI), measured by production-based CO_2 productivity and GDP per unit of energy-related CO_2 emission.

Table 1. Variables and Data Source

Variables	Abbreviation	Unit/measurement	Source
Green Growth	GG	GDP per unit of energy-related CO2 emission	WDI
Renewable Energy Consumption	REC	% of Total Energy Consumption	OECD
Population	POP	Total Population	WDI
Direct Investment	FDI	Net Inflow, % of GDP	OECD
Environmental Policy StringencyIndex	EPS	Index, between 0 to 6	OECD
Environmental Policy Stringency of Market-Based Policies	MEPS	Index, between 0 to 6	OECD
Environmental Policy Stringency of Non-Market-Based Policies	NMEPS	Index, between 0 to 6	OECD
Control of Corruption	COC	Index, between -2.5 to +2.5	WGI
Political Stability	PS	Index, between -2.5 to +2.5	WGI
Terrorism	TERR	Deaths due to Terrorist Activities	Global Terrorism Database

The time frame for our analysis spans from 1996 to 2020. This study aims to unravel the intricate relationships shaping green growth dynamics in BRICS nations. The selected time period is primarily motivated by data availability for the variables considered. Panel models enable us to account for individual-specific effects, time-specific effects, and their interactions (Hsiao, 2003), given the unique characteristics of BRICS nations. Wang's (2015) work, particularly on the implementation of the “xthreg” command in Stata, significantly contributes to this evolving field. The combination of fixed-effect models and threshold analysis addresses the complex challenges posed by heterogeneity in panel data.

3.2. Methods

We employ a fixed-effect panel threshold econometric model incorporating key variables to explore the dynamics of green growth and its determinants in BRICS countries. Hansen's (1999) pioneering fixed-effect panel threshold model laid the foundation for examining structural breaks and regime shifts in economic relationships. The simplicity of its specification, coupled with its profound implications for economic policy, has inspired researchers to explore its application across various domains. Wang's work, through the introduction of the “xthreg” command in Stata, enhances the accessibility and practical implementation of the fixed-effect panel threshold model, as expressed by the following equation.

$$Y_{it} = \mu + X_{it}(q_{it} < \tau)\beta_1 + X_{it}(q_{it} \geq \tau)\beta_2 + u_i + e_{it} \quad (1)$$

The variable q_{it} serves as the threshold variable, and γ represents the threshold parameter, delineating the equation into two regimes characterised by coefficients β_1 and β_2. The parameter u_i corresponds to the individual effect, and e_{it} denotes the disturbance. (Wang, 2015). Each equation (mentioned as a continuous model in the table) was developed

separately to investigate the individual effects of policy stringency. Equations (2) and (3) include EPS, equations (4) and (5) include MEPS, and equations (6) and (7) include NEPS, respectively.
The study utilises the following six models:

Model 1

$$GG_{it} = \alpha + \beta_1 REC_{it} + \beta_2 POP_{it} + \beta_3 FDI_{it} + \beta_4 TERR_{it} + \beta_5 EPS_{it} + \beta_6 |(COC < \tau; COC \geq \tau \; + \mu_i + \varepsilon_{it} \quad (2)$$

Model 2

$$GG_{it} = \alpha + \beta_1 REC_{it} + \beta_2 POP_{it} + \beta_3 FDI_{it} + \beta_4 TERR_{it} + \beta_5 EPS_{it} + \beta_6 |(PS < \tau; PS \geq \tau \; + \mu_i + \varepsilon_{it} \quad (3)$$

Model 3

$$GG_{it} = \alpha + \beta_1 REC_{it} + \beta_2 POP_{it} + \beta_3 FDI_{it} + \beta_4 TERR_{it} + \beta_5 MEPS_{it} + \beta_6 |(COC < \tau; COC \geq \tau \; + \mu_i + \varepsilon_{it} \quad (4)$$

Model 4

$$GG_{it} = \alpha + \beta_1 REC_{it} + \beta_2 POP_{it} + \beta_3 FDI_{it} + \beta_4 TERR_{it} + \beta_5 MEPS_{it} + \beta_6 |(PS < \tau; PS \geq \tau \; + \mu_i + \varepsilon_{it} \quad (5)$$

Model 5

$$GG_{it} = \alpha + \beta_1 REC_{it} + \beta_2 POP_{it} + \beta_3 FDI_{it} + \beta_4 TERR_{it} + \beta_5 NMEPS_{it} + \beta_6 |(COC < \tau; COC \geq \tau \; + \mu_i + \varepsilon_{it} \quad (6)$$

Model 6

$$GG_{it} = \alpha + \beta_1 REC_{it} + \beta_2 POP_{it} + \beta_3 FDI_{it} + \beta_4 TERR_{it} + \beta_5 NMEPS_{it} + \beta_6 |(PS < \tau; PS \geq \tau \; + \mu_i + \varepsilon_{it} \quad (7)$$

Here, τ is the threshold parameter associated with each institutional indicator.

4. Results and Discussions

This section deals with the empirical results and discussion. Table 2 provides a comprehensive overview of the descriptive statistics for the explanatory variables under consideration. These statistics include key parameters such as the mean, standard deviation, and count values, summarising the distributional properties inherent in the variables. Table 3 presents the explanatory variables' correlation matrix, highlighting their interrelationships and associations. The correlation coefficients quantify the strength and direction of linear relationships between pairs of variables. The results indicate that there are no strong correlations among the variables.

Table 2. Descriptive Statistics

Variables	Mean	SD	Observations
GG	3.08816	2.146915	125
POP	5.82e+08	5.64e+08	125
FDI	2.248089	1.30723	125
REC	23.68296	16.95958	125
EPS	0.9837778	0.7711748	125
MEPS	0.4613333	0.3293689	125
NMEPS	2.006	1.547782	125
TERR	146.256000	226.102065	125

Table 3. Correlation Among Explanatory Variables

Variables	GG	REC	POP	FDI	EPS	MEPS	NMEPS	TERR
GG	1							
REC	0.7585	1						
POP	-0.1920	0.2631	1					
FDI	0.2659	0.1882	0.1399	1				
EPS	-0.1258	-0.0596	0.5983	-0.2195	1			
MEPS	-0.3050	-0.2617	0.4342	-0.2348	0.7672	1		
NMEPS	-0.1992	-0.1216	0.6030	-0.2385	0.9656	0.7018	1	
TERR	-0.0941	0.2645	0.4134	-0.2599	0.3081	0.3796	0.1177	1

Tables 4 and Table 5 outline the estimated coefficients for fixed-effect panel threshold models. Building on the findings of various studies (Chen & Tanchangya, 2021; Wu & Zhang, 2022; Tawiah et al., 2021), these models incorporate renewable energy consumption and population as control variables, providing a comprehensive understanding of the factors influencing the dynamics of green growth.

Table 4. Estimated Coefficients for Models-1, 2 & 3

Variables	Model 1	Model 2	Model 3
REC	0.01075252***	0.0100911***	0.0036754***
POP	1.856112*	0.6812607***	2.638124*
FDI	-0.0067672***	-0.0330447***	-0.0183218***
TERR	-0.0361781*	-0.0251869***	-0.0436935*
EPS	0.2733971*	0.2690894*	-
MEPS	-	-	0.4175895*
NMEPS	-	-	-
Threshold(τ)	-1.0176	-0.9726	-1.0176
0	0.320455**	0.3986847*	0.2713712***
1	0.6685843*	-0.0057455***	0.5613166*

Note: *, ** & *** indicates 1%, 5% & 10% level of significance.

The results from all six models consistently indicate that FDI harms green growth. These results support the 'pollution heaven hypothesis', where developed nations try to shift pollution-intensive products and technologies to countries with weak environmental regulations. This could lead to undermining green initiatives of the underdeveloped and developing nations – these findings are in line with the findings of Cole et al. (2005), Pao &

Tsai (2011), and Shahbaz et al. (2018), and opposite to studies conducted by Xiao et al. (2023).

Table 5. Estimated Coefficients for Model-4,5 & 6

Variables	Model 4	Model 5	Model 6
REC	0.0049245***	0.0185833*	0.0141474***
POP	1.696303*	1.470097*	0.3901781***
FDI	-0.0012178***	0.0033497***	-0.0260538***
TERR	-0.0276466***	-0.0417698*	-0.032028**
EPS	-	-	-
MEPS	0.6333843*	-	-
NMEPS	-	0.2009684*	0.1749105*
Threshold(τ)	0.1637	-1.0176	-0.9726
0	0.1264361*	0.1264361*	0.3545582*
1	0.5381894**	0.5381894**	-0.0369783***

Note: *, ** & *** indicates 1%, 5% & 10% level of significance.

The significance of terrorism is evident exclusively in models where political stability serves as the threshold variable, implying a nuanced relationship between terrorism and sustainable development. Terrorism creates uncertainty and reduces green innovations, and mobilisations of domestic defence forces lead to more fossil fuel consumption, leading to the deterioration of green growth. These findings are in line with the previous findings of Bildirici and Gokmenoglu (2020), Zeng et al.(2021), and Tahir et al. (2022). This finding suggests that the impact of terrorism on economic and environmental dimensions becomes statistically relevant only under specific conditions of corruption control and political stability. The implications of this observation extend to the realm of policy formulation, emphasising the interconnectedness of institutional quality and sustainable development efforts.

In theory, stricter environmental policies should enhance green growth, but trade-offs exist between growth and stringent policies (Rahman et al., 2020). Models 1 and 2 demonstrate that environmental policy stringency is statistically significant, serving as threshold parameters for controlling corruption and political stability. In examining the relationships in models 3 and 4, it is notable that increased environmental policy stringency in market-based policies consistently corresponds to improved green growth. Similarly, in models 5 and 6, the stringency of non-market-based environmental policies is statistically significant and positively influences green growth. These results contrast with Li Chen and Papel Tanchangya's (2022) findings, who reported the relationship between environmental policy stringency and green growth as statistically insignificant in the long run. Additionally, the findings by Arjomandi et al. (2023) do not support the Porter Hypothesis, which posits that environmental policy stringency positively influences green productivity and GDP growth in OECD countries. Wang et al. (2019) also observed that environmental policies can negatively affect green productivity growth in OECD countries when the degree of environmental regulation surpasses a certain level, as the compliance cost effect outweighs the innovation offset effect. Furthermore, the statistical significance of NMEPS highlights the importance of non-market-based instruments in promoting environmental quality in BRICS nations.

Our explanatory variables, such as renewable energy and population growth, exhibit a positive influence on green growth. The empirical literature highlights that renewable energy sources are less carbon-intensive and produce fewer emissions compared to traditional energy sources (Shafiei & Salim, 2014; Chen et al., 2022). Therefore, transitioning from non-renewable to renewable energy is crucial for BRICS nations in their pursuit of sustainable development goals. Regarding population growth, economies of scale may foster a positive relationship by promoting the adoption of solar and wind energy in emerging economies (IRENA, 2020). Furthermore, Carréon and Worrell (2018) argue that urbanisation can enhance energy efficiency and reduce emissions by implementing green city initiatives. This is particularly relevant for BRICS nations, where rapid urbanisation is driving a significant demographic shift from rural to urban areas.

We have applied a panel fixed effect with robust standard errors to test the reliability and efficiency of our panel threshold regression results. Table 6 presents the outcomes of robustness tests conducted to validate the stability and reliability of the empirical findings. These tests systematically implemented variations in model specifications, such as alternative control variables, including control of corruption and political stability. Fixed effect panel regression results conclude that the estimated results from threshold models are consistent.[4]

Table 7 showcases the outcomes of Pesaran's test, a diagnostic tool used to scrutinise the presence of cross-sectional dependence in the dataset. Cross-sectional dependence can compromise the validity of statistical inferences, making Pesaran's test instrumental in identifying and addressing this issue. The table displays relevant test statistics, clearly determining the absence of cross-sectional dependence.

Table 6. Robustness Test Results.

Variables	Model 1	Model 2
REC	0.0119898	0.0147137***
POP	1.656669*	0.8530152*
FDI	0.0125958	-0.0008669
EPS	0.2944394*	0.340905*
COC	0.5802836*	-
PS	-	0.4229091*

Note: *, ** & *** indicates 1%, 5% & 10% level of significance.

Table 7. Pesaran's Cross-Sectional Dependence Test Results.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Pesaran's test	1.082	-0.242	1.575*	-0.630	1.811	-0.089

5. Conclusions

The primary findings of this study indicate that both renewable energy and stringent environmental policies significantly contribute to promoting green growth in BRICS economies. Consequently, these nations should reevaluate their economic and environmental strategies to capitalize on these insights. While previous studies, such as those by Chen and Tanchangya (2022) and Arjomandi et al. (2023), reported mixed or insignificant findings,

[4] We have reported the results including EPS. The findings for MEPS and NMEPS remain consistent as well. Due to space constraints, we have not included these regression results in the manuscript.

this study provides contrasting evidence for BRICS countries. It shows that increased environmental policy stringency, particularly market-based policies, consistently correlates with improved green growth. This finding underscores the need for a more nuanced understanding of the impact of environmental policies on green growth, considering the specific policy instruments used.

To foster increased investment in renewable energy initiatives, policymakers should consider offering targeted policy incentives that make such investments more attractive. Policymakers and stakeholders should tailor counter-terrorism strategies to address immediate security concerns and potential economic and environmental repercussions. This is particularly important in regions where political stability is a crucial threshold determinant in green growth. More comprehensive and effective policies can be developed by recognising the interconnectedness of security, economic stability, and environmental sustainability. Therefore, policymakers and governments must promote green innovation by allocating more resources to research and development in green technology. This approach supports sustainable development goals and ensures long-term environmental and economic benefits.

References

Abid, M. (2017). Does economic, financial and institutional developments matter for environmental quality? A comparative analysis of EU and MEA countries. Journal of environmental management, 188, 183-194.

Alam, M. S., & Kabir, N. (2013). Economic growth and environmental sustainability: empirical evidence from East and South-East Asia. International Journal of Economics and Finance, 5(2).

Albrizio S, Koźluk T, & Zipperer V (2017). Environmental policies and productivity growth: Evidence across industries and firms. Journal of Environmental Economics and Management, 81, 209–226. https://doi.org/10.1016/j.jeem.2016.06.002

Arjomandi, A., Gholipour, H. F., Tajaddini, R., & Harvie, C. (2023). Environmental expenditure, policy stringency and green economic growth: evidence from OECD countries. Applied Economics, 55(8), 869-884.

Ayamba, E. C., Haibo, C., Abdul-Rahaman, A. R., Serwaa, O. E., & Osei-Agyemang, A. (2020). The impact of foreign direct investment on sustainable development in China. Environmental Science and Pollution Research, 27, 25625-25637.

Azman-Saini WNW, & Law SH (2010). FDI and economic growth: New evidence on the role of financial markets. Economics Letters, 107(2), 211-213. https://doi.org/10.1016/j.econlet.2010.01.027

Balsalobre-Lorente D, Shahbaz M, Roubaud D, & Farhani S (2018). How economic growth, renewable electricity, and natural resources contribute to CO2 emissions? Energy Policy, 113, 356-367. https://doi.org/10.1016/j.enpol.2017.10.050

Baltagi BH (2021). Econometric analysis of panel data. In: Springer texts in business and economics. https://doi.org/10.1007/978-3-030-53953-5

Behera P, & Sethi N (2022). Nexus between environment regulation, FDI, and green technology innovation in OECD countries. Environ Sci Pollut Res, 1–14. https://doi.org/10.1007/s11356-022-19458-7

Bildirici, M., & Gokmenoglu, S. M. (2020). The impact of terrorism and FDI on environmental pollution: evidence from Afghanistan, Iraq, Nigeria, Pakistan, Philippines, Syria, Somalia, Thailand and Yemen. Environmental Impact Assessment Review, 81, 106340.

Bilgen S (2014). Structure and environmental impact of global energy consumption. Renewable and Sustainable Energy Reviews, 38 890-902. https://doi.org/10.1016/j.rser.2014.07.004

Birdsall N & Wheeler D (1993). Trade policy and industrial pollution in Latin America: where are the pollution havens? The Journal of Environment & Development, 2(1), 137-149. http://dx.doi.org/10.1177/107049659300200107

Birdsall, N., & Wheeler, D. (1993). Trade policy and industrial pollution in Latin America: where are the pollution havens?. The Journal of Environment & Development, 2(1), 137-149.

BRICS INDIA (2021). | Ministry of External Affairs. (n.d.). Retrieved from https://brics2021.gov.in/about-brics

Carréon, J. R., & Worrell, E. (2018). Urban energy systems within the transition to sustainable development. A research agenda for urban metabolism. Resources, Conservation and Recycling, 132, 258-266.

Chai J, Hao Y, Wu H, & Yang Y (2021). Do constraints created by economic growth targets benefit sustainable development? Evidence from China. Business Strategy and the Environment, 30(8), 4188-4205. https://doi.org/10.1002/bse.2864

Chang, C. P., & Hao, Y. (2017). Environmental performance, corruption and economic growth: global evidence using a new data set. Applied economics, 49(5), 498-514.

Chen Yin-E, Li C, Chang C-P, & Zheng M (2021). Identifying the influence of natural disasters on technological innovation. Economic Analysis and Policy, 70, 22-36. https://doi.org/10.1007/s11356-022-22989-8

Chen, C., Pinar, M., & Stengos, T. (2022). Renewable energy and CO2 emissions: New evidence with the panel threshold model. Renewable Energy, 194, 117-128.

Chen, L., & Tanchangya, P. (2022). Analyzing the role of environmental technologies and environmental policy stringency on green growth in China. Environmental Science and Pollution Research, 29(37), 55630-55638.

Cole, M. A., & Elliott, R. J. (2005). FDI and the capital intensity of "dirty" sectors: a missing piece of the pollution haven puzzle. Review of Development Economics, 9(4), 530-548.

Crawford NC (2019) Pentagon fuel use, climate change, and the costs of war.

Dercon, S. (2014). Is green growth good for the poor? The World Bank Research Observer, 29(2), 163-185.

Gaibulloev K., & Sandler T (2008). Growth consequences of terrorism in Western Europe. Kyklos, 61(3), 411–424. https://doi.org/10.1111/j.1467-6435.2008.00409.x

Global Terrorism Index (2019): Measuring the Impact of Terrorism, Retrieved from - www.economicsandpeace.org.

Green Growth Knowledge Platform (GGKP 2015). Measuring Environmental Action and Economic Performance in Developing Countries, Working Paper, GGKP Research Committee on Trade and Competitiveness, UNEP 01|2015.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of econometrics, 93(2), 345-368.

Haug, A. A., & Ucal, M. (2019). The role of trade and FDI for CO2 emissions in Turkey: Nonlinear relationships. Energy Economics, 81, 297-307.

Hille, E., & Shahbaz, M. (2019). Sources of emission reductions: Market and policy-stringency effects. Energy Economics, 78, 29-43.

Hsiao, C. (2003). Analysis of Panel Data. 2nd ed. Cambridge: Cambridge University Press.

Huberty M, & Zachmann G (2011). Green exports and the global product space- Prospects for EU industrial policy. Working Papers 556, Bruegel.

India, B. R. I. C. S. (2021). Ministry of external Affairs.

Jacobs M (2012). Green Growth: Economic Theory and Political Discourse. GRI Working Papers 92, Grantham Research Institute on Climate Change and the Environment.

Jan AA, Lai F W, Draz MU, Tahir M, Ali SEA, Zahid M, & Shad MK (2021). Integrating sustainability practices into Islamic corporate governance for sustainable firm performance: From the lens of agency and stakeholder theories. Quality & Quantity, 1-24. https://doi.org/10.1007/s11135-021-01261-0

Jebli, M. B., & Youssef, S. B. (2017). The role of renewable energy and agriculture in reducing CO2 emissions: Evidence for North Africa countries. Ecological indicators, 74, 295-301.

Khan Z, Shahbaz M, Ahmad M, Rabbi F, & Siqun Y (2019). Total retail goods consumption, industry structure, urban population growth and pollution intensity: an application of panel data analysis for China. Environmental Science and Pollution Research, 26, 32224-32242. https://doi.org/10.1007/s11356-019-06326-0

Khan, K., & Su, C. W. (2021). Urbanization and carbon emissions: a panel threshold analysis. Environmental Science and Pollution Research, 28, 26073-26081.

Khan, M. K., Teng, J. Z., Khan, M. I., & Khan, M. O. (2019). Impact of globalization, economic factors and energy consumption on CO2 emissions in Pakistan. Science of the total environment, 688, 424-436.

Kruse, T., et al. (2022). Measuring environmental policy stringency in OECD countries: An update of the OECD composite EPS indicator, OECD Economics Department Working Papers, No. 1703, OECD Publishing, Paris. https://doi.org/10.1787/18151973

Liang L, Chen M, Luo X, & Xian Y (2021). Changes pattern in the population and economic gravity centers since the Reform and Opening up in China: The widening gaps between the South and North. Journal of Cleaner Production, 310, 127379. https://doi.org/10.1016/j.jclepro.2021.127379

Lu X, & Yan K (2022). Unleashing the dynamic and nonlinear relationship among new-type urbanization, foreign direct investment, and inclusive green growth in China: an environmental sustainability perspective.

Environmental Science and Pollution Research, 30(12), 33287–33297. https://doi.org/10.1007/s11356-022-24503-6

Martinez-Zarzoso I, Bengochea-Morancho A, & Morales-Lage R (2019). Does environmental policy stringency foster innovation and productivity in OECD countries? Energy Policy, 134, 110982. https://doi.org/10.1016/j.enpol.2019.110982

Martínez-Zarzoso, I., Bengochea-Morancho, A., & Morales-Lage, R. (2019). Does environmental policy stringency foster innovation and productivity in OECD countries?. Energy Policy, 134, 110982.

Nguyen C P, Nguyen NA, Schinckus C, & Su TD (2018). The ambivalent role of institutions in the CO2 emissions: The case of emerging countries. International Journal of Energy Economics and Policy, 8(5), 7.

OECD (2015). Towards Green Growth?: Tracking Progress, OECD Green Growth Studies, OECD Publishing, Paris, https://doi.org/10.1787/9789264234437-en.

OECD (2024). Environmental policy: Environmental Policy Stringency index, OECD Environment Statistics (database), https://doi.org/10.1787/2bc0bb80-en.

Pao, H. T., & Tsai, C. M. (2011). Multivariate Granger causality between CO2 emissions, energy consumption, FDI (foreign direct investment) and GDP (gross domestic product): evidence from a panel of BRIC (Brazil, Russian Federation, India, and China) countries. Energy, 36(1), 685-693.

Pata UK (2018). Renewable energy consumption, urbanization, financial development, income and CO2 emissions in Turkey: testing EKC hypothesis with structural breaks. Journal of Cleaner Production, 187, 770-779. https://doi.org/10.1016/j.jclepro.2018.03.236

Porter, M. E., & Linde, C. V. D. (1995). Toward a new conception of the environment-competitiveness relationship. Journal of economic perspectives, 9(4), 97-118.

Rahman MM, Saidi K, & Mbarek MB. (2020). Economic growth in South Asia: the role of CO2 emissions, population density and trade openness. Heliyon, 6(5). https://doi.org/10.1016/j.heliyon.2020.e03903

Renewable Energy and Jobs Annual Review-2020, Retrieved from-https://www.irena.org/publications/2020/Sep/Renewable-Energy-and-Jobs-Annual-Review-2020.

Saidi K & Omri A (2020). Reducing CO2 emissions in OECD countries: do renewable and nuclear energy matter? Progress in Nuclear Energy, 126, 103425. https://doi.org/10.1016/j.pnucene.2020.103425

Salahuddin M, Alam K, Ozturk I, & Sohag K. (2018). The effects of electricity consumption, economic growth, financial development and foreign direct investment on CO2 emissions in Kuwait. Renewable and Sustainable Energy Reviews, 81, 2002-2010. https://doi.org/10.1016/j.rser.2017.06.009

Sarkodie SA, & Adams S (2018). Renewable energy, nuclear energy, and environmental pollution: accounting for political institutional quality in South Africa. Science of the Total Environment, 643, 1590-1601. https://doi.org/10.1016/j.scitotenv.2018.06.320

Shafiei, S., & Salim, R. A. (2014). Non-renewable and renewable energy consumption and CO2 emissions in OECD countries: a comparative analysis. Energy policy, 66, 547-556.

Shahbaz M, Gozgor G, Adom PK, & Hammoudeh S (2019). The technical decomposition of carbon emissions and the concerns about FDI and trade openness effects in the United States. International Economics, 159, 56-73. https://doi.org/10.1016/j.inteco.2019.05.001

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitão, N. C. (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. Renewable and sustainable energy reviews, 25, 109-121.

Shahbaz, M., Nasir, M. A., & Roubaud, D. (2018). Environmental degradation in France: the effects of FDI, financial development, and energy innovations. Energy economics, 74, 843-857.

Sun Y, Ding W, Yang Z, Yang G, & Du J (2020). Measuring China's regional inclusive green growth. Science of the Total Environment, 713, 136367. https://doi.org/10.1016/j.scitotenv.2019.136367

Tahir M, Burki U, Azid T (2022). Terrorism and environmental sustainability: Empirical evidence from the MENA region. Resources, Environment and Sustainability, 8, 100056. https://doi.org/10.1016/j.resenv.2022.100056

Tanchangya P, Chowdhury NH, & Chu Y (2019). Impact on growth of institutional entrepreneur and economic growth through returning industry transfer. Journal of Business and Economic Development, 4(4), 134. https://doi.org/10.11648/j.jbed.20190404.12

Tawiah ., Zakari A, & Adedoyin FF (2021). Determinants of green growth in developed and developing countries. Environ Sci Pollut Res, 28(39227–39242). https://doi.org/10.1007/s11356-021-13429-0

Tseng ML, Chang CH, Lin CWR, Wu KJ, Chen Q, Xia L, & Xue B (2020). Future trends and guidance for the triple bottom line and sustainability: A data driven bibliometric analysis. Environmental Science and Pollution Research, 27, 33543-33567. https://doi.org/10.1007/s11356-020-09284-0

Vujanović N, Stojčić N, & Hashi I (2021). FDI spillovers and firm productivity during crisis: Empirical evidence from transition economies. Economic Systems, 45(2), 100865. https://doi.org/10.1016/j.ecosys.2021.100865

Wang Q (2015). Fixed-Effect Panel Threshold Model using Stata. The Stata Journal, 15(1), 121–134. https://doi.org/10.1177/1536867X150150010

Wang, P., Deng, X., Zhou, H., & Yu, S. (2019). Estimates of the social cost of carbon: A review based on meta-analysis. Journal of cleaner production, 209, 1494-1507.

WCED, S. W. S. (1987). World commission on environment and development. Our common future, 17(1), 1-91.

WCED, S. W. S. (1987). World commission on environment and development. Our Common Future, 17(1), 1-91.

Xiao, D., Gao, L., Xu, L., Wang, Z., & Wei, W. (2023). Revisiting the green growth effect of foreign direct investment from the perspective of environmental regulation: evidence from China. International Journal of Environmental Research and Public Health, 20(3), 2655.

Yang X, Wang J, Cao J, Ren S, Ran Q, & Wu H (2021). The spatial spillover effect of urban sprawl and fiscal decentralization on air pollution: evidence from 269 cities in China. Empirical Economics, 1-29. https://doi.org/10.1007/s00181-021-02151-y

Yao Y, Hu D, Yang C, & Tan Y (2021). The impact and mechanism of fintech on green total factor productivity. Green Finance, 3, 198-221. https://doi.org/10.3934/GF.2021011

Yi-Ming W, & Zhang Y (2022). The impact of environmental technology and environmental policy strictness on China's green growth and analysis of development methods. Journal of Environmental and Public Health, 2022, 1–10. https://doi.org/10.1155/2022/1052824

Zhang, Z., Chen, H., & Wu, L. (2024). How does technological innovation drive green growth in China's complex environments? A configurational approach. Journal of Environmental Planning and Management, 67(11), 2583-2604.

Zheng M, Feng G-F, Jang C-L, & Chang C-P (2021). Terrorism and green innovation in renewable energy. Energy Economics, 104, 105695. https://doi.org/10.1016/j.eneco.2021.105695.

Zhou, G., Zhu, J., & Luo, S. (2022). The impact of fintech innovation on green growth in China: Mediating effect of green finance. Ecological Economics, 193, 107308.